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THE RELATIONSHIP BETWEEN SELF-REPORTED ANXIETY AND BIORHYTHMS.(U)
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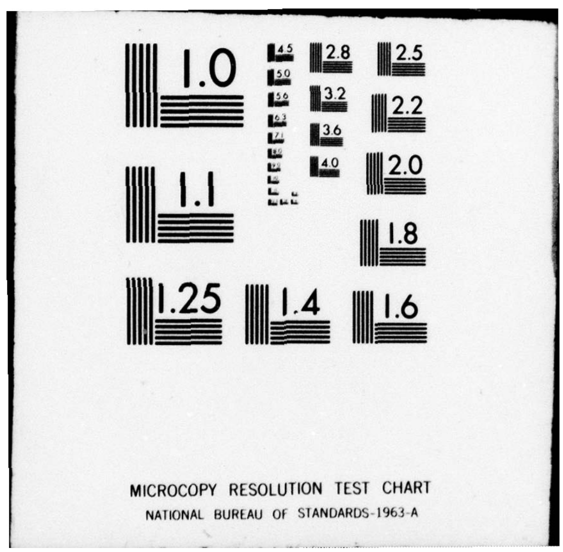
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THE RELATIONSHIP BETWEEN
SELF-REPORTED ANXIETY AND BIORHYTHMS

THESIS

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9 Master's THESIS,

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In Partial Fulfillment of the

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Master of Science

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by

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## Preface

Stress has been labeled one of the major health problems in this country. It has been linked to hypertension, coronary disease, migraine and tension headaches, and peptic ulcers. It is believed that high levels of stress can lead to depression, alcoholism, drug addiction, and to breakdowns in normal relations with friends and family. One important source of stress arises from the individual's own anxiety style. This paper represents my efforts to provide added insights into an understanding of anxiety.

I would like to thank Major Saul G. C. Young for his guidance, suggestions, and interest throughout this effort. I am grateful to the many fellow students whom took valuable time from their busy schedules to complete the survey upon which this study is based. And, of course, I would like to thank my wife Pat for her tolerance and assistance during this project.

Frederick W. Howe

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## Abstract

This research was conducted to investigate the relationship of anxiety to biorhythms. Two groups of Air Force Institute of Technology students were administered the State-Trait Anxiety Inventory: the first group received eight surveys over a period of four weeks, the second group received only one survey. State and trait anxiety scores greater than one standard deviation about the group mean were tabulated against 'non-critical' and 'critical' biorhythm periods. Four hypotheses (and variations) were tested for higher than expected levels of anxiety occurring on critical days. A fifth hypothesis was tested for the rhythmicity of individual A-State anxiety scores.

Hypotheses concerning the existence of relationships of intellectual and composite cycle critical periods to anxiety scores were rejected. Significant results at levels of $\alpha \leq .05$ were found in both groups of high levels of anxiety greater than chance occurring on emotional cycle critical days in persons high in A-Trait when allowances were made for differences in time of birth. The data suggests that a relationship might exist between physical critical days and higher levels of state anxiety. Persons high in A-Trait tend to be more sensitive to biorhythms than persons low in A-Trait. It was concluded that levels of anxiety may be influenced by biological fluctuations (rhythms) over time.

THE RELATIONSHIP BETWEEN

SELF-REPORTED ANXIETY AND BIORHYTHMS

## I. Introduction

For centuries man has sought to remove the uncertainty in his life. He has sought knowledge of the unknown, and once knowledge is gained he has used it to remove the uncertainty. He creates environments where uncertainty is nonexistent. He has surrounded himself with a number of devices which allow him to make the cold days warmer, the hot days cooler, and the dry days wetter. He has created snow, ice, lakes, and artificial light for his convenience and enjoyment.

One frontier of knowledge has evaded man's attempts to remove the uncertainty and to simplify the complex. That is man's understanding of man. More research and writing has been done in this area than in any other. It includes topics such as medicine, biology, religion, sociology, psychology, literature, philosophy, and parapsychology.

In the area of biology, research has led to the discovery of numerous biological rhythms which have been used to explain or predict certain occurrences. Some research has indicated that these biological rhythms in turn cause or coincide with rhythms in man's emotions and

moods. This paper will explore the possibility of biological rhythms existing in one of these emotions, anxiety.

Anxiety

The term anxiety was introduced into psychology in 1894 by Freud. Freud considered anxiety as a signal for danger; distinguishing between objective anxiety (fear) and neurotic anxiety, depending on whether the danger came from the outside world or from internal impulses (Eysenck, 1972:68). Freud believed the origin of anxiety to be the birth trauma. Freud saw the birth experience as

> ...an experience which involved just such a concatenation of painful feelings, of discharges and excitation, and of bodily sensations, as to have become a prototype for all occasions on which life is endangered, ever after to be reproduced again in us as the dread of 'anxiety' condition (May, 1977:141).

But the acceptance of anxiety in psychology did not become general until the publication in 1950 of Rollo May's book, The Meaning of Anxiety. Additionally, interest in anxiety research was stimulated by the development in the early 1950's of a number of psychometric instruments designed to assess fear and anxiety (Spielberger, 1972:6).

Since the 1950's, there has been a large amount of work done to improve man's understanding of anxiety. A great deal has been learned about ways of assessing anxiety, about the variables that anxiety is correlated with, and about techniques for the clinical treatment

for weakening levels of anxiety (McReynolds, 1976:35). At the same time though, there has been a lack of consensus as to the conceptual meaning of anxiety, and little agreement as to how it should be measured. Another problem has been the use of stress and anxiety as synonyms in recent literature.

Stress refers to the objective stimulus properties of a situation - it puts emphasis on what happens to the person. A situation that is objectively stressful will be perceived as dangerous or threatening to most people. But whether or not a stressful situation is perceived as threatening by a particular person will depend upon his own subjective evaluation of the situation. Moreover, objectively nonstressful situations may be appraised as threatening by individuals who, for some reason, perceive them as dangerous. The evaluation of a situation as dangerous or threatening will be determined, in part, by an individual's personality and past experience with similar situations.

Anxiety is an emotion very similar to fear but without a specific referent. Anxiety tends to be a diffuse feeling of uneasiness and tension not associated with any specific stimulus. May views anxiety as the way an individual relates to stress, accepts it, and interprets it (May, 1977:113). Anxiety is how man handles stress.

Numerous theories have been proposed about the concept of anxiety but each contributor seemed to approach

the problem of anxiety with his own unique theoretical orientation and research methods. One widely accepted concept of anxiety views anxiety as consisting of two factors: 'state anxiety', which fluctuates as a function of situations and conditions of the organism; and 'trait anxiety', which is a summary of the frequency and intensity of past states and predisposes the individual to perceive situations in particular ways and to react in a consistent manner to a wide variety of situations (Zuckerman, 1976:133). This paper will use the specific concepts of state and trait anxiety developed by Charles A. Spielberger (1970, 1972).

State-Trait Anxiety. Spielberger conceptualized state anxiety (A-State) as a transitory emotional state or condition of the human organism that is characterized by subjective, consciously perceived feelings of tension and apprehension, and heightened autonomic nervous system activity (Spielberger, 1970:3). State anxiety may vary in intensity and fluctuate over time. Trait anxiety (A-Trait) was defined as anxiety proneness, or an individual's predisposition to respond to heightened levels of state anxiety in stressful situations (Hodges, 1976:177). Persons who are high in A-Trait tend to perceive a larger number of situations as dangerous or threatening than persons who are low in A-Trait, and to respond to threatening situations with A-State elevations of greater intensity.

Spielberger's concept of anxiety makes certain assumptions about A-State and A-Trait anxiety. First, it is assumed that once a situation is perceived as threatening then an A-State reaction will evolve, and the intensity of the reaction will be proportional to the amount of threat the situation poses for the individual. Second, the duration of the A-State reaction will depend upon the persistence of the situation and the individual's prior experience in dealing with similar situations. If a stressful situation is encountered frequently the individual may develop coping responses that reduce or remove the danger, thereby reducing the level of A-State intensity. Third, different levels in A-State would be expected for persons who differ in A-Trait under situations posing some threat to self-esteem, but not in situations that involve physical danger (Spielberger, 1972:44).

<u>Biological Rhythms</u>

In his book, <u>Biological Rhythms and Human Performances</u>, Colquhoun states:

> It has long been known that most, if not all, biological processes are rhythmic or cyclical in character, that is, they consist of sequences of events which repeat themselves at regular intervals. The sequence may be very simple or extremely complex, and the time span, or period of a particular cycle may be anything from a fraction of a second to many years. Such rhythms occur in all forms of life, and man is no exception(Colquhoun, 1971:vii).

In man, each cell has a number of biological rhythms, and their behavior affects and is affected by the rhythms of

all other cells. The length of these cycles fit into three categories: infradian, circadian, and supradian cycles. Infradian cycles, such as brain waves, are those that take less than a day to complete and affect certain body functions.

Circadian cycles are the best known and most widely researched. These are daily cycles which are observed in body temperature, blood pressure, brain activity, hormone levels, and work and rest. Not only are these cycles observed in physiological factors but have been observed in mental performance, physical coordination, and in moods such as anxiety, depression, cheerfulness, and friendliness (Palmer, 1976:143). Studies indicate that these rhythms are derived from both internal and external cues (Gittelson, 1978:28-29).

Supradian cycles are rhythms that take more than a day to complete. Research on these are not as complete due to the costs, length of time involved, and the increased difficulty in controlling exogenous variables. Supradian rhythms have been noted in cases of somatic and mental illnesses (Richter, 1965), male moods (Gittelson, 1978:36), and pain sensitivity (Palmer, 1976:171-172). However, the best known and researched of the supradian cycles is the menstrual cycle.

The menstrual cycle is one of the earliest observed low frequency rhythms known to mankind. It has been commonly observed that women experience changes in per-

ception during the menstrual cycle. It is estimated that from 25% to 100% of women experience some form of premenstrual or menstrual emotional distrubance, depending on the definition used (O'Connor, 1974:312). Symptoms of premenstrual tension include anger, irritability, emotional instability, anxiety, depression, and the flare-up of chronic illness (Gittelson, 1973:33). These rhythmic mood changes occur whether the woman is neurotic, psychotic, or "normal" (O'Connor, 1974:320).

## Biorhythms

The word biorhythm is an abbreviation of biological rhythms and refers to a theory concerning three specific supradian cycles: physical, emotional, and intellectual.

Background of Biorhythm Theory. Biorhythm theory was developed shortly before 1900 by two men working independently. Dr. Hermann Swoboda, a professor of psychology at the University of Vienna, noticed a regular rhythm to the dreams, ideas, and creative impulses of his patients. He began to keep detailed records on pain and swelling in his patient's tissue, and plotted the course of fevers, the onset and development of other illnesses, and the frequency with which people suffered heart attacks and bouts of asthma (Gittelson, 1978:41). From this data, he noticed recurring rhythmic cycles of 23 and 28 days.

Dr. Wilhelm Fliess, an eminent nose and throat

specialist in Berlin, first began to suspect the existence of biorhythms while attempting to discover why children exposed to the same diseases remained immune for varying periods of time (Gittelson, 1978:44). He collected extensive data about the onset of illness, fever, and death, and related them to the day of birth. He also noted cycles of 23 and 28 days.

A third contributor to biorhythm theory was an Austrian teacher named Alfred Teltscher. Teltscher noticed that even his best students seemed to have both good and bad days, and began to collect information about how well high school and college students did on examinations, the dates of the exams, and the birth dates of the students (Gittelson, 1978:46). After statistically searching through the data he discovered a regular cycle of 33 days.

Biorhythm Theory. The theory states that from birth to death each person is influenced by three internal cycles - the physical, the emotional, and the intellectual. On the day of birth, each cycle begins at a zero baseline and progresses in a positive direction until a maximum point is reached. At this point, the cycles begin a negative slope, passing through the baseline and proceeding until a maximum negative point is reached. Then the cycle begins an upward slop passing through the baseline and beginning the cycle again (Fig 1). The 23 day physical rhythm affects a broad range of physical factors, including resistance to disease,

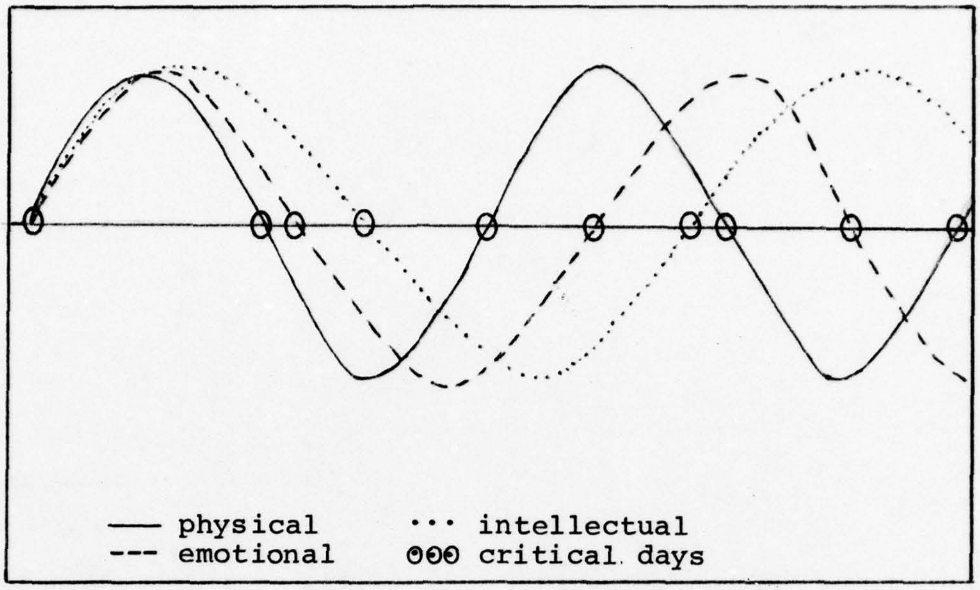


Figure 1. The Three Biorhythmic Cycles (Sacher, 1974:10)

strength, coordination, and sensation of physical well-being. The 28 day emotional rhythm affects sensitivity, mood, and perceptions of the environment. The 33 day intellectual rhythm influences memory, alertness, and logic.

All three cycles have the shape of a sine-wave, with a positive and negative half cycle. Energies and abilities associated with each cycle are high during the positive half cycle. During the negative phase, energies are recharged and our physical, emotional, and intellectual capabilities are low, or at least somewhat diminished. Increased amounts of energy are picked up until, at the end of each, the baseline is recrossed into the positive

phase, and the whole process begins again. According to the theory, the weakest and most vulnerable moments do not occur in the negative phase, but rather, occur when each cycle crosses the baseline (Gittelson, 1978:15). These occur when crossing from positive to negative, or from negative to positive. The cross-over days from one phase to another are called critical days and occur twice for each cycle. In addition to the days where one cycle crosses the baseline, there are also double-critical days (two cycles intersect the baseline at or near the same point) and triple critical days (all three cycles intersect the baseline at or near the same point).

Recent Studies Using Biorhythms. Biorhythms have been used to predict or explain a number of events. Generally the studies have dealt with accidents or performance, with findings ranging from no relation to biorhythms to a strong suggestion of a cause and effect relationship. Table I is a summary of recent studies and their findings.

## Anxiety and Biorhythms

The circadian nature of anxiety (Palmer, 1976:143), and the supradian characteristics of male moods (Gittelson, 1978:36) and premenstrual tension (O'Connor, 1974:312) have already been discussed. Additional studies report various biological cycles for different emotions (Parlee, 1978:82-91) and biorhythms associated with self-reported emotional states (Burstein, 1975), but there have been no

Table I
Summary of Recent Studies
Related to Biorhythm Theory

| Source | Type of Data | Number of Cases | Findings |
|---|---|---|---|
| Berube (1977) | Measured Performance in College Students | 51 | No significant relationship |
| Harley (1978) | Nursing Activity | 74 | No significant relationship |
| Kauth (1976) | Acute Myocardial Infarction | 3079 | No significant relationship (.05) |
| McPhail (1976) | Performance on Selected Skill Tests | 100 | No significant relationship (.05) |
| Burstein (1975) | Perceived Emotional States | 21 | Support 23 and 28 day cycles |
| Johnson (1974) | Football Injuries | 164 | No significant relationship (.05) |
| Yates (1974) | Students in Fraternities and Sororities | 80 | No significant relationship (.05) |
| Mance (1976) | Motor Performance | 39 | Supports 23 day cycle for "fine" motor skills but not for "gross" motor skills (.05) |
| Chase (1976) | Performances of Professional Women Golfers | 26 | No significant relationship |
| Latman (1977) | Motor Vehicle Accidents | 260 | Supports the theory |
| Neil (1976) | Information Processing Task | 3 | Supports existence of biological rhythms, not necessarily biorhythm theory (.05) |
| Kahlil (1977) | Accident Occurrence and Performance | 397 | No significant relationship (.05) |
| Hendrick (1977) | Aircraft Accidents and Incidents | 100 | Supports 23 day cycle (.025) |
| Carvey (1977) | Industrial Accidents | 360 | No significant relationship (.05) |
| Wolcott (1975) | Aircraft Accidents | 4279 | No significant relationship (.10) |
| Sacher (1974) | Aircraft Accidents | 4346 | Some support when age of pilot considered |
| Nett (1975) | Industrial Accidents | 400 | No significant relationship (.05) |

studies that attempt to relate one specific emotion to the biorhythm theory.

Hypotheses

State anxiety was defined as a transitory emotional state that varies in intensity and fluctuates over time. This paper will examine the relationship of those fluctuations to biorhythms. Because state anxiety is characterized by subjective, consciously perceived feelings, changes in state anxiety are caused by a number of situations encountered by the individual. Additionally, changes in elevations in state anxiety may also be influenced by biological, environmental, and physiological determinants. Given identical situations, it is assumed that an individual will experience different levels of state anxiety based upon his position on the biorhythm curves.

The main hypothesis to be tested is that higher than expected levels of state anxiety occur on critical days. High levels of anxiety are defined as measures of anxiety greater than one standard deviation above a group or individual mean. The relationship of anxiety to critical days is implied in the studies of Swoboda. Swoboda noticed that new mothers began to show anxiety about their infants whenever a critical day occurred or was about to occur (Gittelson, 1978:41).

The main hypothesis leads to four specific hypotheses to be tested. The first three will test the critical

days of each individual cycle against high levels of state anxiety (Fig 2). The fourth hypothesis will test the critical days of all three cycles taken simultaneously against high levels of state anxiety (Fig 3).

The first four specific hypotheses to be tested are:

Hypothesis 1 - Higher than expected levels of state anxiety occur on physical cycle critical days.

Hypothesis 2 - Higher than expected levels of state anxiety occur on emotional cycle critical days.

Hypothesis 3 - Higher than expected levels of state anxiety occur on intellectual cycle critical days.

Hypothesis 4 - Higher than expected levels of state anxiety occur on biorhythm theory critical days.

The biorhythm theory assigns identical cycles to all persons born on the same day but makes no allowances for time of birth (Sacher, 1974:47). Therefore, according to the theory a person born at 12:01 a.m. would have the same critical days as a person born at 11:59 p.m. even though their time of birth is one day apart. To compensate for this, Hypotheses 1 through 4 will also be tested for three day critical periods (critical day plus and minus one).

The fifth hypothesis to be tested will analyze individual state anxiety scores over a period of time. It is expected that differences in state anxiety scores will

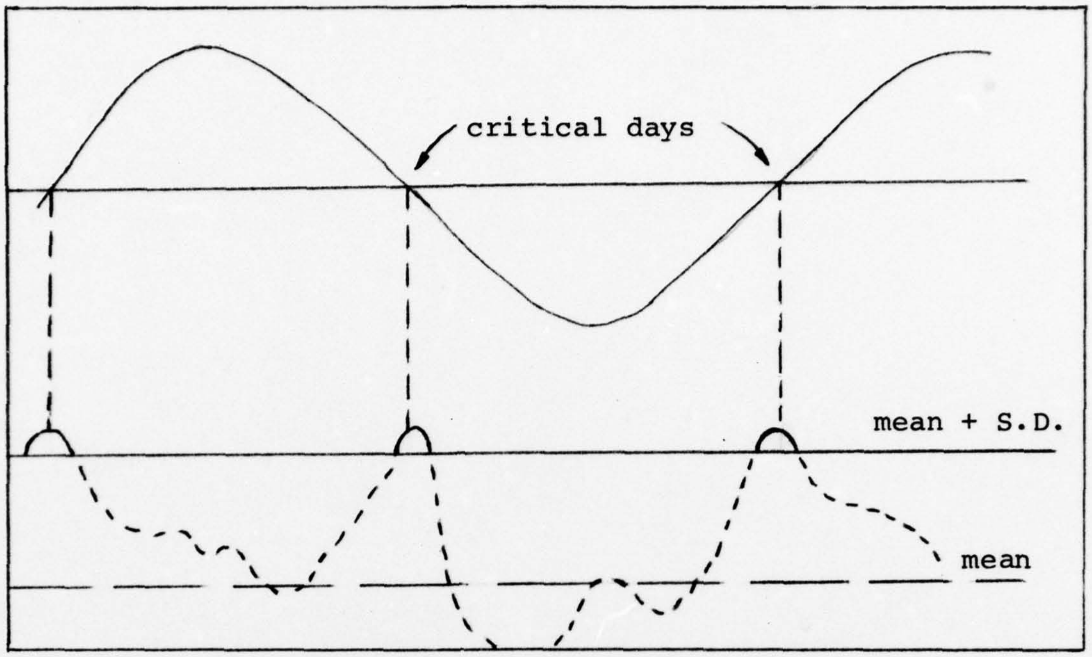


Figure 2. Hypothesized Relationship Between Individual Biorhythm Cycle Critical Days and State Anxiety Scores

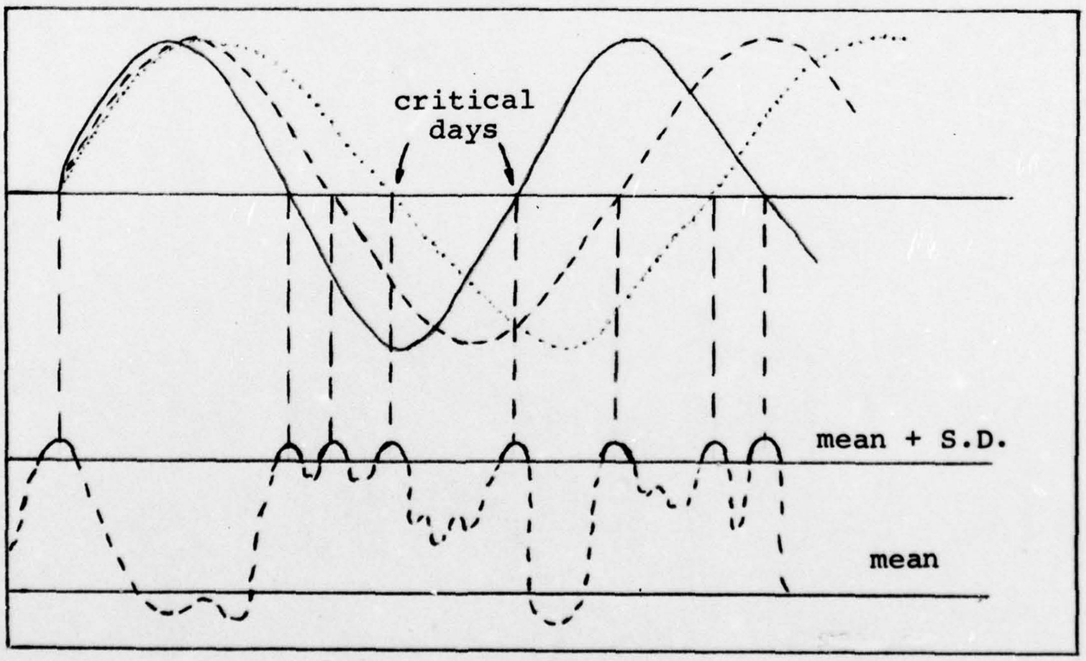


Figure 3. Hypothesized Relationship Between Biorhythm Critical Days and State Anxiety Scores

not be random.

Hypothesis 5 - State anxiety fluctuates in a periodic, cyclical manner.

Gittelson observed that some people appear to be more sensitive to biorhythms than others and labeled the two groups as "rhythmists" and "non-rhythmists" (Gittelson, 1978:131). This idea combined with Spielberger's observation that persons high in A-Trait respond to threatening situations with A-State elevations of greater intensity than persons low in A-Trait will provide the basis for the final set of hypotheses. For these hypotheses, persons with trait scores greater than the group mean will be considered persons high in A-Trait. These people will be expected to be more sensitive to biorhythms than persons low in A-Trait. Hypotheses 1 through 4 will again be tested but only for people high in A-Trait.

Finally, trait anxiety scores will be tested against the five hypotheses. Trait scores are expected to remain stable over time but will be tested because of the availability of the data and to note any trends that may appear.

## Summary and Preview

This chapter began with a discussion of anxiety beginning with the views of Freud through the concept of state-trait anxiety as developed by Charles Spielberger. Infradian, circadian, and supradian biological rhythms were presented followed by a discussion of biorhythms, a

specific theory about certain supradian rhythms. The development of biorhythms, as well as a summary of recent research into biorhythms was presented. The chapter concluded with five testable hypotheses (including variations) concerning relationships between state anxiety and critical days.

Chapter II will present the methodology used to collect the data and to calculate the probabilities of critical days (or periods). Additionally, Chapter II will present a discussion of the time series analysis used to test Hypothesis 5.

Chapter III will present the data, test the hypotheses, and discuss the findings. Chapter IV will draw conclusions from the findings of this research and make recommendations for, or about, future research.

## II. Methodology

Before any analysis begins, it is necessary to define the methods, steps, and assumptions made to arrive at that point. The purpose of this chapter is to provide the framework upon which the analysis of the hypotheses was made. The framework required in this research needed to examine mathematically the probabilities associated with the occurrence of critical days to allow for a statistical evaluation of levels of anxiety scores against random occurrence. This chapter will cover the areas of: 1) data selection and collection, 2) the relationship of critical days to biorhythm cycles, 3) statistical tests for the relationship of critical days to anxiety scores, and 4) statistical tests for the rhythmic properties of state anxiety scores.

### Data Selection

The first concern involved the selection of an acceptable measure of anxiety. This required a choice between a physiological measure and a psychological one. A psychological measure was chosen because of its ease of administration and because it met other constraints such as time and availability. The *State - Trait Anxiety Inventory* (STAI) was chosen due to its relationship to the theory of anxiety adopted for this research.

The STAI is comprised of separate self-report scales

for measuring the two distinct anxiety concepts: state anxiety and trait anxiety. The STAI A-Trait scale consists of 20 statements that ask the respondents to describe how they generally feel. The STAI A-State scale also consists of 20 statements, but the instructions require subjects to indicate how they feel at that particular moment in time. The STAI has been validated in studies of junior and senior high school students, college freshmen, college undergraduates, and of neuropsychiatric, medical, and surgical patients (Spielberger, 1970:3).

The only other information needed for the study was data about the individual's biorhythms. This was obtained from the individual's date of birth and the date the STAI was completed.

## Data Collection

Data was collected by two methods. The first method involved a series of surveys given over a period of time. The survey consisted of the STAI with a cover letter containing a privacy statement, instructions about the survey, and questions concerning date of birth and date of STAI completion (Appendix A). Completion of the survey was done voluntarily by U.S. military officers attending the Air Force Institute of Technology. Initially the survey was given to 50 randomly selected officers. Volunteers in the exercise were asked to complete a total of eight surveys covering a period of four weeks. The four week

period insured scores from both negative and positive phases of the theorized biorhythm cycles. The surveys were distributed through the officer's student mail boxes, and were completed at their convenience to minimize any increases in anxiety caused by administration of the instrument.

The second data collection method was the administration of the survey on a one time basis, in class, to newly assigned students (all U.S. officers). This method involved giving verbal instructions recommended in the STAI Manual (Spielberger, 1970:4). This data provided a basis of comparison with the data gathered by the first method.

Data Recording and Computing

For each survey returned, seven data points were recorded or computed. The data points were: 1) date of birth, 2) date of survey completion, 3) day along the physical cycle, 4) day along the emotional cycle, 5) day along the intellectual cycle, 6) state anxiety score, and 7) trait anxiety score.

The day along any particular biorhythm cycle is the remainder from dividing the total number of days since the data of birth by the separate biorhythm cycle lengths. These results were verified against tables found in Gittelson's book Biorhythms (Gittelson, 1978).

The STAI was hand-scored using a key available with

the STAI Manual. Each set of 20 statements were added together to arrive at A-State and A-Trait scores. If a subject omitted one or two items on either the STAI A-State or A-Trait scales, his prorated full-scale score was obtained by multiplying the mean score of the items to which the subject responded by 20 and rounding to the next higher whole number (Spielberger, 1970:5). If three or more items were omitted, the score was not recorded.

Relationship of Critical Days to Biorhythm Cycles

The critical days of the three cycles have normally been defined as follows:

| | | |
|---|---|---|
| 23 day cycle | : | Days 1 and 12; |
| 28 day cycle | : | Days 1 and 15; |
| 33 day cycle | : | Days 1 and 17 (Sacher, 1974:26). |

For this study, these definitions will be altered in two ways. First, the date used for the analysis has been presented as days along a cycle - a remainder. Therefore, the first day of a cycle has a remainder of zero and is a critical day. The three cycle durations are defined as 0 to 22, 0 to 27, and 0 to 32. This yields the same results as above and is only a difference in notation.

The second alteration to the normal definition of critical days is due to the integer properties of the data. Because the physical and intellectual cycles have odd-number durations, the midpoint critical days occur with 12 hours of the critical period occurring in day 11 (or day 16) and the remaining 12 hours occurring in day 12

(or day 17). To compensate for this, the midpoint critical periods for the physical and intellectual cycles were made 48 hours long instead of 24 hours. The results of the two alterations yielded the following definition of critical days for this study:

| | | |
|---|---|---|
| 23 day cycle | : | Days 0, 11, and 12; |
| 28 day cycle | : | Days 0 and 14 |
| 33 day cycle | : | Days 0, 16, and 17. |

<u>Multiple</u> - <u>Criticality</u>. To make allowances for differences in time of birth, the hypotheses were tested using expanded critical periods. The expanded critical periods were formed by adding and subtracting one day from each of the critical periods previously defined. For this study, multiple-criticality is defined as:

| | | |
|---|---|---|
| 23 day cycle | : | Days 0, 1, 10, 11, 12, 13, and 22; |
| 28 day cycle | : | Days 0, 1, 13, 14, 15, and 27; |
| 33 day cycle | : | Days 0, 1, 15, 16, 17, 18, and 32. |

## <u>Probabilities of the Occurrence of Critical Days (Periods)</u>

In order to test the three different critical period cycle days interpretations against anxiety scores, it is necessary to determine the probabilities of random occurrence for each of the three cycles. Table II contains the probabilities for each of the three cycles with singular critical periods. Table III contains the probabilities for multiple-criticality.

To establish probabilities associated with Hypothesis

Table II

Probabilities of Critical Periods (Singular)

| Event | Probability |
|---|---|
| Physical P(PHY) | $\frac{3}{23} = .13043$ |
| Emotional P(EMO) | $\frac{2}{28} = .07143$ |
| Intellectual P(INT) | $\frac{3}{33} = .09091$ |

Table III

Probabilities of Critical Periods (Multiple)

| Event | Probability |
|---|---|
| Physical P(PHY1) | $\frac{7}{23} = .30435$ |
| Emotional P(EMO1) | $\frac{6}{28} = .21429$ |
| Intellectual P(INT1) | $\frac{7}{33} = .21212$ |

4, it is necessary to employ a set theoretical model where:

A = set of all non-critical days;

B = set of all physical critical days;

C = set of all emotional critical days;

D = set of all intellectual critical days;

and

$B \cap C$ = set of all double critical days, physical/emotional

$B \cap D$ = set of all double critical days, physical/intellectual;

$C \cap D$ = set of all double critical days, emotional/intellectual;

$B \cap C \cap D$ = set of all triple critical days.

These relationships are illustrated by Venn Diagrams in Figure 4. The probability of a critical day when all three cycles are considered then becomes:

$$P\ (\text{critical}) = P(B) + P(C) + P(D) - P(B \cap C) - P(B \cap D) - P(C \cap D) + P(B \cap C \cap D) \qquad (1)$$

where P(B), P(C) and P(D) are the probabilities associated with the physical, emotional and intellectual cycles found in Table II. Table IV contains the probabilities of the intersections found in Eq (1). The probability of a biorhythmic critical day is .26595. This is greater than the .20356 generally reported due to the increased length of the midcycle critical period for the physical and intellectual cycles.

<u>Probabilities for Multiple-Criticality</u>. To test

Table IV

Intersection Probabilities
(Singular)

| Event | Set | Probability |
|---|---|---|
| Phy/Emo | $B \cap C$ | $\frac{3}{23} \times \frac{2}{28} = .00932$ |
| Phy/Int | $B \cap D$ | $\frac{3}{23} \times \frac{3}{33} = .01186$ |
| Emo/Int | $C \cap D$ | $\frac{2}{28} \times \frac{3}{33} = .00649$ |
| Phy/Emo/Int | $B \cap C \cap D$ | $\frac{3}{23} \times \frac{2}{28} \times \frac{3}{33} = .0085$ |

Hypothesis 4 for multiple critical period lengths, it is necessary to substitute the information from Table III and Table V into Eq (1). The probability of a biorhythmic critical day with expanded critical periods is .56936.

### Statistical Tests for the Relationship of Critical Days to High A-State Anxiety

Contingency tables of 2 rows and 2 columns were used to tabulate the data into four groups. For the

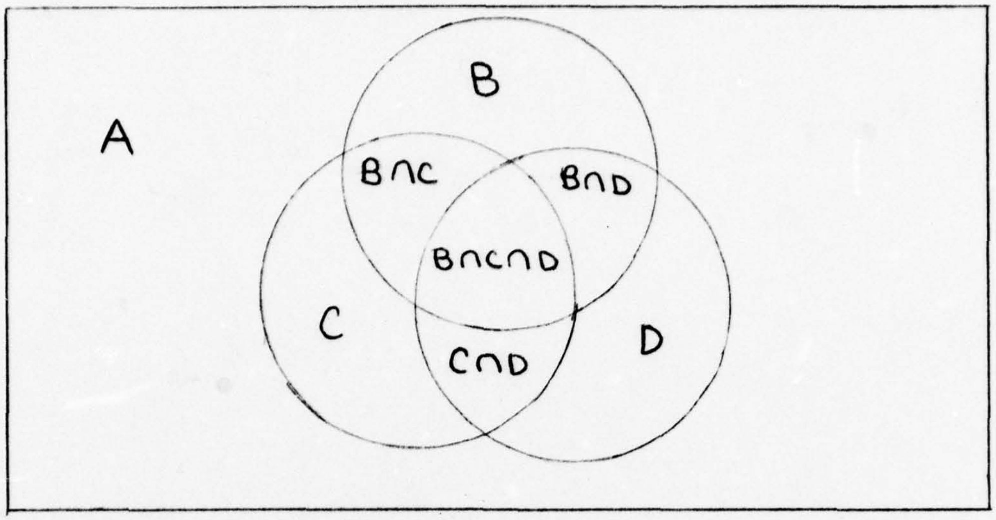


Figure 4. Set Theoretical Model for the Calculation of Probabilities for Biorhythm Critical Days (Sacher, 1974:20)

tables, the row categories were 'non-critical' and 'critical' days; the column categories were 'low/normal' and 'high' levels of anxiety scores (either A-State or A-Trait). If any of the scores occurred on a day along the physical cycle (23 day) defined earlier as critical, they were tabulated as 'critical' for Hypothesis 1. Remaining scores were counted as 'non-critical' for Hypothesis 1. The same tabulation method was used for the emotional cycle (28 day) and Hypothesis 2, and for the intellectual cycle (33 day) and Hypothesis 3. For Hypothesis 4, a score was tabulated as 'critical' if it was defined as critical for the 23 day cycle <u>or</u> the 28 day cycle <u>or</u> the 33 day cycle, otherwise, it was counted as 'non-critical'.

Table V

Intersection Probabilities
(Multiple)

| Event | Set | Probability |
|---|---|---|
| Phy 1/Emo 1 | $B \cap C$ | $\frac{7}{23} \times \frac{6}{28} = .06522$ |
| Phy 1/Int 1 | $B \cap D$ | $\frac{7}{23} \times \frac{7}{33} = .06456$ |
| Emo 1/Int 1 | $C \cap D$ | $\frac{6}{28} \times \frac{7}{33} = .04545$ |
| Phy 1/Emo 1/Int 1 | $B \cap C \cap D$ | $\frac{7}{23} \times \frac{6}{28} \times \frac{7}{33} = .01383$ |

For each group, a group mean and standard deviation was calculated using SPSS (Statistical Package for the Social Sciences) (Nie, 1975). Scores were classified as 'low/normal' if they were less than one standard deviation above the group mean and classified 'high' if greater than one standard deviation above the group mean. That is, the dividing point between 'low/normal' and 'high' was the group mean plus one standard deviation.

The null hypothesis for all four hypotheses (and variations) was that the probability of a high A-State

anxiety score occurring on a critical day was statistically equal to the probability of a critical day. In other words, high levels of anxiety do not occur significantly greater than chance on critical days. To analyze the data, tests concerning proportions were used. From the contingency tables, only values classified as high levels of anxiety were selected. This yielded high A-State scores that occurred either on 'critical' days or 'non-critical' days - a binomial distribution. The probabilities used in the null hypothesis were the probabilities of critical days found in Tables II and III and calculated from Eq (1). The tests of the null hypothesis $p=p_o$ were based on the statistic:

$$z = \frac{x - np_o - .5}{\sqrt{np_o\ (1-p_o)}} \qquad (2)$$

where

$x$ = number of high A-State scores occurring on critical days

$n$ = total number of high A-State scores

$p_o$ = probability of a critical day

$p$ = $x/n$ - the proportion of high A-State scores occurring on critical days for this study.

Since the data is a discrete distribution, the .5 is subtracted as a correction for lack of continuity. The null hypothesis is to be rejected based upon the one-sided alternative $p > p_o$ when $z > z_\alpha$.

If n was small and either np or n(p - 1) was less than 5, then the values of the binomial distribution were computed using the form:

$$f(x) = \binom{n}{x} \; p_o^x \; (1-p_o)^{n-x} \qquad (3)$$

For the one-tail test, values of f(x) were calculated and accumulated beginning with x=n and continuing with successive declining values of x until the probability of getting a value in the 'tail' was as close as possible to the level of significance without exceeding it (Freund, 1973:313).

To illustrate this type of test, suppose the probability of a critical day is .25 ($p_o$=.25) and we are interested in the significance at the .10 ($\alpha$=.10) level of at least 4 high A-State scores occurring on critical days from a sample of 5. First, calculate the probability of all 5 occurring on a critical day:

$$f(5) = \binom{5}{5} \; (.25)^5 \; (.75)^0 = .0097$$

then the probability of 4 and add:

$$f(4) + f(5) = .015 + .001 = .016$$

then the probability of 3 and add:

$$f(3) + f(4) + f(5) = .088 + .016 = .104$$

Thus, the probability of at least 4 high A-State scores occurring on a critical day is significatly different than chance at the .10 level, and the proportion .8 (4 ÷ 5 or x/n) is significantly different than .25. Additionally,

for any value of x less than 4 the null hypothesis could not be rejected.

## Statistical Tests for the Rhythmic Properties of State Anxiety

In the study of biological rhythms all quantitities of concern are approximately periodic functions of time (Batschelet, 1974:25). In this study, it was hypothesized that state anxiety scores would be a trigonometric function of time (Hypothesis 5). To attempt to find a satisfactory fit it was necessary to find a nonlinear model that would minimize the unexplained variances. The equation $y=e^z$ is often used as a nonlinear model in the study of biological rhythms. In the equation $y=e^z$,

$$z = M + A \cos (wt-\emptyset) \qquad (4)$$

where

$M$ = the mean level

$A$ = the amplitude

$w$ = the angular frequency

$\emptyset$ = the acrophase, the phase at which the peak of quantity z occurs (Batschelet, 1974:25)

The period T is used to represent the length of the smallest time interval in which the periodic event produces a full cycle. The angular frequency w is related to T by the formula

$$w = 360/T \qquad (5)$$

In the model the values of M, A, w, Ø, and T are all unknown.

When transformed by natural logarithms, the model becomes the linear equation

$$\ln(y) = M + A\cos(wt - \emptyset) \tag{6}$$

where

$y$ = A-State anxiety scores

$t$ = number of elasped days since distribution of the first survey

Values of Ø were estimated from plots of the individual's data points. Values of 10 through 18 for T were entered into the regression analysis. These values were chosen because they approximate the half-cycles of biorhythms. Regression analysis was performed to obtain estimates of M and A. M can be thought of as the mean value of A-State anxiety scores.

An analysis of variance was performed to test the null hypothesis A=0. If the null hypothesis is rejected, then it is concluded that the true amplitude is different from zero, and that the observed rhythm is not spurious. The significance level used for the F ratio for the testing of the null hypothesis was .10.

## Summary

Data used to test the hypotheses was gathered by distributing the State-Trait Anxiety Inventory to two groups of Air Force Institute of Technology students.

Additional data gathered was date of survey completion and the individual's date of birth.

Definitions of critical periods and their probabilities using both a singular period and multiple periods were then presented. These definitions were used to tabulate the data into contingency tables. From this proportions of high A-State anxiety scores to critical days were to be tested for occurrences significantly different than chance.

The chapter concluded with a presentation of a nonlinear model to test for the rhythmicity of A-State anxiety scores.

## III. Data Analysis

Data was collected by two methods: a series of surveys and one time administration. This resulted in two groups of data that were analyzed to test the hypotheses. This chapter will report on the results of the analysis and provide a discussion of the findings.

### Data Base

Students surveyed by the first method were classified as belonging to Group A. Of the 50 students given the initial survey, 26 responded. Return of a blank inventory indicated that the person chose not to participate in the exercise. If three successive inventories were distributed with no response, it was assumed that the individual did not wish to participate. Due to the length of time necessary to complete the set of inventories, there was no attempt to make up for non-volunteers by surveying additional people.

Group A consisted of a total of 164 responses over all 26 respondents. A breakdown of responses by the number of people and the number of responses is as follows:

1 response - 3 people
4 responses - 2 people
5 responses - 2 people
6 responses - 3 people
7 responses - 3 people
8 responses - 13 people

Five responses were missing the date of survey completion, therefore, no information about biorhythms could be calculated. The STAI scores from these responses were used though to compute the group mean and standard deviation.

Students surveyed by the second method were classified as belonging to Group B. Of 90 persons surveyed, all 90 voluntarily completed the survey. Nine persons failed to indicate their date of birth requiring those scores to be used only in calculating the group mean and standard deviation.

State Anxiety Versus Critical Days

Hypotheses 1 through 4 were tested for a relationship of high A-State anxiety scores to critical days significantly different than random occurrence for four variations each. Variation 1 was a single day critical period using all responses; Variation 2 was a multiple day critical period using all responses; Variation 3 was a single day critical period using only A-State scores from respondents with a trait score above the group mean (A-Trait $>$ 35); and Variation 4 was a multiple day critical period using only scores from respondents with a trait score above the group mean.

Values from the contingency tables, and the expected critical day probabilities, were used in either Eq (3) or (4) depending on the values of np and n(1-p).

These results are presented in Table VI for Group A and in Table VII for Group B. The null hypotheses were tested at the .10 level of significance; results that would have been significant if $\alpha$ = .20 are noted for possible trends. The rows labeled 'significance' are the exact probabilities that the true value of the proportion is greater than the probability of a critical day. For example, as shown in Table VI, there is a 51.6 percent chance that the true value of the observed proportion (.143) for Variation 1 is greater than the expected probability of physical cycle critical days (.130).

<u>Trait Anxiety Versus Critical Days</u>

Trait anxiety scores greater than one standard deviation above the group mean were also analyzed by the same methods as state anxiety scores. The results are presented in Table VIII for Group A and in Table IX for Group B.

<u>Individual Rhythms in A-State Anxiety Scores</u>

Hypotheses 1 through 4 were based upon the assumption that the biorhythm theory is correct. The use of such a rigid and all-encompassing theory to explain the complex behavior of man has been attacked by numerous writers (Louis, 1978:93). Hypothesis 5 was tested on individual's scores to see if biorhythms, as they relate to anxiety, are individualistic and vary in cycle length. Twelve respondents with eight usable scores each were

Table VI

Proportion of High A-State Anxiety Scores
Occurring on Critical Days - Group A

| | Hyp. 1 (Phy.) | Hyp. 2 (Emo.) | Hyp. 3 (Int.) | Hyp. 4 (Bior.) |
|---|---|---|---|---|
| <u>Var</u>. <u>1</u> | | | | |
| Expected | .130 | .071 | .091 | .266 |
| Observed | .143 | .114 | .114 | .343 |
| Significance | .516 | .773 | .612 | .800+ |
| <u>Var</u>. <u>2</u> | | | | |
| Expected | .304 | .214 | .212 | .569 |
| Observed | .429 | .286 | .206 | .543 |
| Significance | .921* | .794 | .187 | .316 |
| <u>Var</u>. <u>3</u> | | | | |
| Expected | .130 | .071 | .091 | .266 |
| Observed | .250 | .125 | .0 | .375 |
| Significance | .720 | .560 | .0 | .670 |
| <u>Var</u>. <u>4</u> | | | | |
| Expected | .340 | .214 | .212 | .569 |
| Observed | .625 | .500 | .125 | .750 |
| Significance | .999** | .999** | .470 | .741 |

\+ significant if $\alpha \leq .20$
* significant at $\alpha \leq .10$
** significant at $\alpha \leq .05$

Table VII

Proportion of High A-State Anxiety Scores Occurring on Critical Days - Group B

| | Hyp. 1 (Phy.) | Hyp. 2 (Emo.) | Hyp. 3 (Int.) | Hyp. 4 (Bior.) |
|---|---|---|---|---|
| <u>Var</u>. <u>1</u> | | | | |
| Expected | .130 | .071 | .091 | .266 |
| Observed | .0 | .083 | .0 | .083 |
| Significance | .0 | .419 | .0 | .023 |
| <u>Var</u>. <u>2</u> | | | | |
| Expected | .304 | .214 | .212 | .569 |
| Observed | .333 | .250 | .167 | .583 |
| Significance | .493 | .509 | .232 | .420 |
| <u>Var</u>. <u>3</u> | | | | |
| Expected | .130 | .071 | .091 | .266 |
| Observed | .0 | .250 | .0 | .250 |
| Significance | .0 | .748 | .0 | .284 |
| <u>Var</u>. <u>4</u> | | | | |
| Expected | .304 | .214 | .212 | .569 |
| Observed | .250 | .750 | .0 | .750 |
| Significance | .240 | .968** | .0 | .575 |

** significant at $\alpha \leq .05$

Table VIII

Proportion of High A-Trait Anxiety Scores Occurring on Critical Days - Group A

| | Hyp. 1 (Phy.) | Hyp. 2 (Emo.) | Hyp. 3 (Int.) | Hyp. 4 (Bior.) |
|---|---|---|---|---|
| <u>Var</u>. <u>1</u> | | | | |
| Expected | .130 | .071 | .091 | .266 |
| Observed | .167 | .133 | .100 | .367 |
| Significance | .645 | .844+ | .485 | .851+ |
| <u>Var</u>. <u>2</u> | | | | |
| Expected | .304 | .214 | .212 | .569 |
| Observed | .400 | .233 | .241 | .533 |
| Significance | .826+ | .564 | .564 | .281 |
| <u>Var</u>. <u>3</u> | | | | |
| Expected | .130 | .071 | .091 | .266 |
| Observed | .250 | .125 | .0 | .375 |
| Significance | .720 | .560 | .0 | .670 |
| <u>Var</u>. <u>4</u> | | | | |
| Expected | .304 | .214 | .212 | .569 |
| Observed | .375 | .250 | .125 | .500 |
| Significance | .552 | .463 | .146 | .221 |

+ significant if $\alpha \leq .20$

Table IX

Proportion of High A-Trait Anxiety Scores Occurring on Critical Days - Group B

| | Hyp. 1 (Phy.) | Hyp. 2 (Emo.) | Hyp. 3 (Int.) | Hyp. 4 (Bior.) |
|---|---|---|---|---|
| <u>Var</u>. <u>1</u> | | | | |
| Expected | .130 | .071 | .091 | .266 |
| Observed | .0 | .091 | .091 | .182 |
| Significance | .0 | .450 | .345 | .159 |
| <u>Var</u>. <u>2</u> | | | | |
| Expected | .304 | .214 | .212 | .569 |
| Observed | .455 | .273 | .264 | .727 |
| Significance | .790 | .571 | .807+ | .770 |
| <u>Var</u>. <u>3</u> | | | | |
| Expected | .130 | .071 | .091 | .266 |
| Observed | .0 | .0 | .167 | .151 |
| Significance | .0 | .0 | .239 | .151 |
| <u>Var</u>. <u>4</u> | | | | |
| Expected | .304 | .214 | .212 | .569 |
| Observed | .333 | .0 | .333 | .500 |
| Significance | .421 | .0 | .625 | .223 |

+ significant if $\alpha \leq .20$

analyzed using Eq (6) for phase lengths from 10 to 18 days. Using analysis of variance, the null hypothesis A=0 was tested. Table X presents the probabilities that A, the amplitude, equals zero. Only values less than .15 are presented; values less than .15 and greater than .10 are presented to highlight possible trends, values less than or equal to .10 are considered significant ( $\alpha$ = .10) and are underlined.

Anxiety and Biorhythms

Analysis of Hypotheses 1 through 4 (including variations) on Groups A and B was also conducted to test the independence of anxiety scores and biorhythms. The null hypothesis was that there is no relationship and was tested using the 2 by 2 contingency tables explained in Chapter II. The problem with this type of analysis is that if a relationship is shown to exist, it would not have been possible to determine if the relationship came from critical, positive, or negative periods and whether they were related to low, normal, or high anxiety scores. Therefore, the results are beyond the scope of this study but are presented, with a discussion, in Appendix B for comparison purposes only.

Discussion of Findings

State Anxiety and Critical Days. Hypotheses 3 and 4 (and variations) were rejected due to lack of significant results in both groups. In all there were four significant

Table X

Probabilities of Amplitudes Equal to Zero for
Individual Phase Lengths of State Anxiety Rhythmicity

| Individual | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | . | . | . | . | . | . | . | . | . |
| 2 | .074 | . | . | . | . | . | . | . | . |
| 3 | . | . | . | . | . | . | . | . | . |
| 4 | . | . | . | . | . | . | . | . | . |
| 5 | . | . | . | . | . | . | .107 | .06 | .066 |
| 6 | .146 | . | . | . | . | . | . | . | . |
| 7 | . | . | . | . | . | . | . | . | . |
| 8 | . | . | . | . | . | .119 | .026 | .021 | .055 |
| 9 | .031 | .049 | .07 | . | . | . | . | . | . |
| 10 | . | . | . | . | . | . | . | . | . |
| 11 | . | . | . | .136 | .106 | . | . | . | . |
| 12 | . | . | . | . | . | . | . | .018 | .01 |

results, 3 in Group A and in Group B, each occurring when multiple critical periods were used (Variations 2 and 4). The one significant result in Group B supported one of the results in Group A. Therefore, it is concluded that higher than expected levels of anxiety occur on emotional critical days in persons high in A-Trait when allowances are made for differences in time of birth. In other words, Hypothesis 2 - Variation 4 is accepted; the remaining variations to Hypothesis 2 were rejected.

The two significant results for Hypothesis 1 in Group A were not supported by the results in Group B. Therefore, while it is not possible to accept Hypothesis 1

- Variations 2 and 4, the data does suggest that a relationship might exist between physical critical days and higher levels of state anxiety. Variations 1 and 3 to Hypothesis 1 were rejected.

Trait Anxiety and Critical Days. Although no specific hypotheses were formed about trait anxiety and critical days, the data was analyzed due to its availability. No significant results were discovered, but four results were classified as conditionally significant, if $\alpha = .20$. These four results all occurred in Group A and displayed no pattern among themselves. There appears to be no statistical evidence that trait anxiety is related to biorhythms.

Rhythms in Individual's A-State Anxiety Scores. The analysis of individual's scores demonstrated the existence of rhythmic patterns for some individuals. It is possible that all individuals had rhythmic patterns to their scores but the phase lengths were less than 10 days or greater than 18 days. What this analysis attempted to discover was the phase lengths that might coincide with half cycle lengths of biorhythms. Three individuals had phase lengths approximating 17 days (close to the 16.5 days of the intellectual midcycle). Two individuals had phase lengths approximating 10 days (similar to the 11.5 days of the physical midcycle). These results appear inconsistent with the previous analysis which indicated

there was no relationship of anxiety to the intellectual cycle. A plausible explanation for this inconsistency is that the analysis of individual scores required no common beginning point (i.e., date of birth); or that an intellectual rhythmic cycle for one person would not alter the overall relationship between high A-State scores and the emotional cycle for the entire group.

The analysis supports the claim that state anxiety fluctuates in a periodic, cyclical manner. One trend suggested but not verified statistically, is that persons with high A-Trait anxiety are more sensitive to biorhythms than persons low in A-Trait. Of the five persons with significant rhythmicity, four of them had the highest individual mean trait scores.

## Summary

Analysis of the hypotheses indicated that no relationship exists between intellectual or biorhythm critical days and anxiety. However, the data supported the existence of emotional cycle critical days related to anxiety for people high in A-Trait when allowances are made for differences in time of birth. Also, the data suggested a possible relationship between physical cycle critical days and anxiety. There appears to be no relationship between critical days and trait anxiety.

Some individuals displayed rhythmic properties in their state anxiety responses. The chapter concluded with a trend in rhythmicity noted for persons with higher A-Trait anxiety scores.

## IV. Conclusions and Recommendations

This final chapter will discuss some conclusions drawn from the results of this study. Additional discussion will center on possible implications of the findings and recommendations for improvements in future, similar studies. The chapter will conclude with a summary of this research and its findings.

### Conclusions

Anxiety has been found to change over the course of a day in a rhythmic fashion (Palmer, 1976:143). This study suggests that A-State anxiety also has a supradian rhythm. This rhythmicity does not exist, or is not measurable, for all individuals, but appears to be stronger in persons high in A-Trait anxiety. Therefore, it is concluded that people high in A-Trait are more sensitive to the influence of biological rhythms than persons low in A-Trait.

The only significant results occurring in both groups was for emotional cycle critical days. Since anxiety is an emotion, these results support the claim that the 28 day biorhythm cycle is an emotional cycle. However, the analysis of individual scores showed two clusters of phase lengths for A-State scores, neither of which were centered around a phase length of 14 days. One plausible explanation is that collective scores of the group mask the patterns of individual scores. No attempt was made to resolve this inconsistency

and it will be left to future studies to address.

Significant results in the group analysis only occurred when multiple critical periods were used. It is concluded that the biorhythm theory presented is too rigid and does not allow for variations in time of birth.

In Chapter I, it was acknowledged that fluctuations in levels of anxiety were influenced by any number of determinants and situations. This study attempted to show how levels of anxiety may be influenced by biological fluctuations (rhythms) over time. The results of the analysis suggests that given identical situations and a high sensitivity to emotions (high A-Trait scores), an individual will experience different levels of state anxiety based upon his position on a biological curve. Applied to human problems or performance, an awareness of these rhythms and properties could allow an individual to take advantage of them, or at least not be at a disadvantage because of them (Colquhoun, 1971:35).

## Recommendations

As in most studies, this research raised as many questions as it answered. Therefore, numerous recommendations are made for future, similar studies. First, data should be gathered over a longer period of time than the 28 days used in this study. This writer recommends a minimum of 66 days, as this would allow data to

be gathered over two complete intellectual cycles and almost three physical cycles. Second, data should be gathered more often than twice a week, as was used in this study. This study concentrated on critical days, but with twice-a-week scoring, scores were often received just prior to or just after a critical period, with no real indication of what happened on the critical day. These two recommendations lead to the general recommendation that more data points should be used.

No effort was made to develop a predictive model for anxiety scores. Therefore, a third recommendation would be to analyze 90 percent of the scores and statistically test the ability of a model to forecast correctly the last 10 percent. A fourth recommendation would be to analyze the positive and negative phases as well as critical days. This might also study the effects of triple lows or highs, the intersections of curves, and weights assigned to the different curves.

The administration of surveys to both groups attempted to minimize any increases in anxiety. The final recommendation is to induce stress on one group while maintaining the normal anxiety levels in a control group. Gittelson suggests that biorhythm effects may be masked beneath an apparently average performance unless a situation is challenging in some way (Gittelson, 1978:133). This recommendation is also consistent with the "unmasked" results found in high

A-Trait anxiety individuals.

Summary

This study presented a background on the development of anxiety theory and biorhythm theory. Four hypotheses concerning A-State anxiety and biorhythm theory critical days were formulated. Each of these hypotheses in turn had four variations which were tested for the significance of higher than expected levels of A-State anxiety occurring on critical days. A fifth hypothesis concerning the rhythmicity of A-State scores for individuals was tested by the use of analysis of variance and a nonlinear model.

The study concluded that higher than expected levels of A-State anxiety occur on emotional cycle critical days when allowances are made for differences in time of birth. Also, persons high in A-Trait anxiety tend to be more sensitive to biorhythms than persons low in A-Trait. The study concluded with five recommendations for future, similar studies.

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APPENDIX A

Survey Instrument for Testing the Relationship

Between Anxiety and Biorhythms

## PRIVACY STATEMENT

In accordance with paragraph 30, AFR 12-35, the following information is provided as required by the Privacy Act of 1974:

a. Authority

(1) 5 U.S.C. 301, Departmental Regulation: and/or

(2) 10 U.S.C. 80-12, Secretary of the Air Force, Powers and Duties, Delegation by.

b. Principal purposes. The survey is being conducted to collect information to be used in research aimed at illuminating and providing inputs to the solution of problems of interest to the Air Force and/or DOD.

c. Routine Uses. The survey will be converted to information for use in research of management related problems. Results of the research based on the data provided, will be included in written master's thesis and may also be included in published articles, reports, or texts. Distribution of the results of the research, based on the survey data, whether in written form or orally presented, will be unlimited.

d. Participation in this survey is entirely voluntary.

e. No adverse action of any kind may be taken against any individual who elects not to participate in any or all of this survey.

SCN-78-115
Expires 30 August 1978

## DIRECTIONS

This survey is designed to gather data about AFIT students' perceived feelings over a period of time. Your participation is voluntary and very much appreciated. If you choose not to participate, please return this packet to the mail slot located under the mailroom window. If you do participate you will be asked to complete 8 of these surveys over a period of 4 weeks. If you choose to participate it is important to the success of this survey that you complete all 8 surveys. Each survey will be identical and should take approximately 10 minutes to complete. Each participant in this survey will receive an abstract of the findings upon completion of the study. The surveys will be distributed through your student mail boxes and may be returned to the mail slot located under the mailroom window.

<u>Please do not put your name on the questionnaire</u>. Your answers to these questions will be kept confidential, and no attempt will be made to identify any individual by name. Please note that the Self-Evaluation Questionnaire has <u>two</u> sides to be completed. The front side asks you to indicate how you feel at this moment, the back side asks you to indicate how you generally feel.

The results of these surveys will be incorporated into a Master's thesis to be completed in September 1978 by Captain Frederick Howe. A copy of the thesis will be placed on file in the AFIT School of Engineering library upon completion.

Please complete the following questions. Your responses to these questions are critical to the success of this survey.

What is the <u>date</u> of your birth?
(Month, day, year) ______________________________

On what date did you complete this questionnaire?
(Month, day, year) ______________________________

## SELF-EVALUATION QUESTIONNAIRE

Developed by C. D. Spielberger, R. L. Gorsuch and R. Lushene

**STAI FORM X-1**

NAME ______________________________ DATE ______________

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then blacken in the appropriate circle to the right of the statement to indicate how you *feel* right now, that is, *at this moment*. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

| | NOT AT ALL | SOMEWHAT | MODERATELY SO | VERY MUCH SO |
|---|---|---|---|---|
| 1. I feel calm | ① | ② | ③ | ④ |
| 2. I feel secure | ① | ② | ③ | ④ |
| 3. I am tense | ① | ② | ③ | ④ |
| 4. I am regretful | ① | ② | ③ | ④ |
| 5. I feel at ease | ① | ② | ③ | ④ |
| 6. I feel upset | ① | ② | ③ | ④ |
| 7. I am presently worrying over possible misfortunes | ① | ② | ③ | ④ |
| 8. I feel rested | ① | ② | ③ | ④ |
| 9. I feel anxious | ① | ② | ③ | ④ |
| 10. I feel comfortable | ① | ② | ③ | ④ |
| 11. I feel self-confident | ① | ② | ③ | ④ |
| 12. I feel nervous | ① | ② | ③ | ④ |
| 13. I am jittery | ① | ② | ③ | ④ |
| 14. I feel "high strung" | ① | ② | ③ | ④ |
| 15. I am relaxed | ① | ② | ③ | ④ |
| 16. I feel content | ① | ② | ③ | ④ |
| 17. I am worried | ① | ② | ③ | ④ |
| 18. I feel over-excited and "rattled" | ① | ② | ③ | ④ |
| 19. I feel joyful | ① | ② | ③ | ④ |
| 20. I feel pleasant | ① | ② | ③ | ④ |

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## SELF-EVALUATION QUESTIONNAIRE

### STAI FORM X-2

NAME ______________________________ DATE ____________

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then blacken in the appropriate circle to the right of the statement to indicate how you *generally* feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

| | ALMOST NEVER | SOMETIMES | OFTEN | ALMOST ALWAYS |
|---|---|---|---|---|
| 21. I feel pleasant | 1 | 2 | 3 | 4 |
| 22. I tire quickly | 1 | 2 | 3 | 4 |
| 23. I feel like crying | 1 | 2 | 3 | 4 |
| 24. I wish I could be as happy as others seem to be | 1 | 2 | 3 | 4 |
| 25. I am losing out on things because I can't make up my mind soon enough | 1 | 2 | 3 | 4 |
| 26. I feel rested | 1 | 2 | 3 | 4 |
| 27. I am "calm, cool, and collected" | 1 | 2 | 3 | 4 |
| 28. I feel that difficulties are piling up so that I cannot overcome them | 1 | 2 | 3 | 4 |
| 29. I worry too much over something that really doesn't matter | 1 | 2 | 3 | 4 |
| 30. I am happy | 1 | 2 | 3 | 4 |
| 31. I am inclined to take things hard | 1 | 2 | 3 | 4 |
| 32. I lack self-confidence | 1 | 2 | 3 | 4 |
| 33. I feel secure | 1 | 2 | 3 | 4 |
| 34. I try to avoid facing a crisis or difficulty | 1 | 2 | 3 | 4 |
| 35. I feel blue | 1 | 2 | 3 | 4 |
| 36. I am content | 1 | 2 | 3 | 4 |
| 37. Some unimportant thought runs through my mind and bothers me | 1 | 2 | 3 | 4 |
| 38. I take disappointments so keenly that I can't put them out of my mind | 1 | 2 | 3 | 4 |
| 39. I am a steady person | 1 | 2 | 3 | 4 |
| 40. I get in a state of tension or turmoil as I think over my recent concerns and interests | 1 | 2 | 3 | 4 |

APPENDIX B

Analysis of Anxiety Versus Biorhythms

Using a 2X2 Contingency Table

## Statistical Tests for the Relationship of Biorhythms to Anxiety Scores

The null hypothesis tested was that there is no relationship between biorhythms and anxiety scores. The decisions to accept or reject the null hypotheses were based upon:

$$\chi^2 = \sum_{j=1}^{c} \sum_{i=1}^{r} \frac{(f_{ij} - e_{ij})^2}{e_{ij}} \qquad (7)$$

where:

$r$ = number of rows

$c$ = number of columns

$f_{ij}$ = the observed frequency of the ith row and jth column

$e_{ij}$ = the expected frequency of the ith row and jth column.

The expected frequency of a cell ($e_{ij}$) is equal to the cell probability times the total number of observed events. If the two classifications are independent of each other, a cell probability will equal the product of its respective row and column probabilities. Therefore, the expected value of row 1 and column 1 is:

$$e_{11} = n\left(\frac{r_1}{n}\right)\left(\frac{c_1}{n}\right) = \frac{r_1 c_1}{n}$$

where

$r_1$ = total number of values in row 1

$c_1$ = total number of observed values in column 1

$n$ = total number of observed values.

This leads to the general equation for expected cell frequencies:

$$e_{ij} = \frac{r_i c_j}{n} \tag{8}$$

The null hypothesis is rejected if the value obtained from Eq (7) exceeds $\chi^2_{\alpha,\ (r-1)\ (c-1)}$. When this happens, it is concluded that there is a relationship between biorhythms and anxiety scores.

The chi-square test of the 2X2 contingency tables used 1 degree of freedom [(2-1),(2-1) = 1] and a level of significance of $\alpha$=.10. Therefore, any computed chi-square values greater than 2.7 $\left(\chi^2_{.1,1}\right)$ were significant to the .10 level. When degrees of freedom equal 1 and any expected frequency is small, less than 10, a chi-square computed for such data is likely to be an overestimate and may lead to erroneous conclusions. Because the distribution of scores was discrete, it was necessary to apply Yates' correction for lack of continuity, so Eq (7) became:

$$\chi^2 = \sum_{j=1}^{c} \sum_{i=1}^{r} \frac{(f_{ij} - e_{ij} - .5)^2}{e_{ij}} \tag{9}$$

<u>Example of the Chi-Square of One Contingency Table</u>. The contingency table of Hypothesis 1 - Variation 1 (state anxiety versus physical cycle using single critical periods) for Group A was:

| | Low/Normal | High | |
|---|---|---|---|
| Non-critical | 111 | 30 | 141 |
| Critical | 13 | 5 | 18 |
| | 124 | 35 | 159 |

The expected cell frequencies using Eq (8) were:

$$e_{11} \quad \frac{(141)(124)}{159} = 110$$

$$e_{12} \quad \frac{(141)(35)}{159} = 31$$

$$e_{21} \quad \frac{(18)(124)}{159} = 14$$

$$e_{22} \quad \frac{(18)(35)}{159} = 4$$

The value of $\chi^2$ using Eq (9) becomes:

$$\chi^2 = \frac{(111-110 - .5)^2}{110} + \frac{(30-31 - .5)^2}{31} + \frac{(13-14 - .5)^2}{14} + \frac{(5-4 - .5)^2}{4}$$

$$= .002 + .008 + .018 + .063$$

$$= .091$$ (differs from Table XI value because of rounding errors).

This value is less than 2.7, therefore, the null hypothesis that there is no relationship between the physical cycle and anxiety scores is accepted.

<u>State Anxiety Versus Biorhythms</u>. Thirty-two (2 groups

X 4 variations X 4 hypotheses) contingency tables were analyzed for relationships between state anxiety and biorhythms. Table XI presents the chi-square values of the analysis. Significant values ( $\alpha$ =.10) are noted. Results that would have been significant if $\alpha$=.15 are also presented to highlight possible trends.

Trait Anxiety Versus Biorhythms. Trait anxiety scores were also tested for Groups A and B using Hypotheses 1 through 4 with the four variations. The results are presented in Table XII.

## Discussion

The only results in Table XI that were critical or 'of interest' occurred in the emotional cycle. Additionally, those results all occurred when multiple critical periods were considered. This leads to the conclusion that anxiety is related to the emotional biorhythm cycle when variations in time of birth are considered. Even though one result in Table XII was significant no pattern emerges and no conclusions can be made.

Table XI

Chi-Square Values of 2X2 Contingency Tables of State Anxiety Versus Biorhythms

| | Hyp. 1 (Phy.) | Hyp. 2 (Emo.) | Hyp. 3 (Int.) | Hyp. 4 (Bior.) |
|---|---|---|---|---|
| <u>Group A</u> | | | | |
| Var. 1 | .11 | 1.58 | .02 | 1.41 |
| Var. 2 | 1.55 | 3.29* | .03 | .07 |
| Var. 3 | .07 | .01 | .30 | .00 |
| Var. 4 | 1.07 | 2.43+ | .19 | .87 |
| <u>Group B</u> | | | | |
| Var. 1 | .01 | .01 | .69 | .34 |
| Var. 2 | .08 | .12 | .24 | .54 |
| Var. 3 | 1.64 | 1.64 | .01 | .05 |
| Var. 4 | .22 | 4.42** | .81 | .34 |

+ significant if $\alpha \leq .15$

* significant at $\alpha \leq .10$

** significant at $\alpha \leq .05$

Table XII

Chi-Square Values of 2X2 Contingency Tables of Trait Anxiety Versus Biorhythms

| | Hyp. 1 (Phy.) | Hyp. 2 (Emo.) | Hyp. 3 (Int.) | Hyp. 4 (Bior.) |
|---|---|---|---|---|
| <u>Group A</u> | | | | |
| Var. 1 | .48 | 2.46+ | .03 | 1.84 |
| Var. 2 | .49 | .55 | .01 | .00 |
| Var. 3 | .06 | .01 | .31 | .00 |
| Var. 4 | .04 | .09 | .22 | .01 |
| <u>Group B</u> | | | | |
| Var. 1 | .03 | .03 | .08 | .15 |
| Var. 2 | 1.49 | .26 | .18 | 2.90* |
| Var. 3 | .86 | .86 | .05 | .33 |
| Var. 4 | .05 | .75 | .18 | .14 |

+ significant if $\alpha \leq .15$

* significant at $\alpha \leq .10$

## Vita

Frederick W. Howe was born in Ithaca, New York on November 7, 1949. He graduated from high school in Lansing, New York in 1967 and attended the State University of New York (SUNY) at Alfred from which he received in 1969 an Associate's degree in Data Processing. He then continued his education at SUNY at Potsdam from which he graduated in 1970 with a Bachelor's degree in Computer Science.

After a period of unemployment, he then entered the Air Force in 1971 and upon completion of Officer Training School received a commission as a second lieutenant. After completing navigator training at Mather Air Force Base, he operationally flew the C-130 at Langley Air Force Base, Virginia; Korat Air Base, Thailand; Clark Air Base, Philippines; and Dyess Air Force Base, Texas. He entered the Air Force Institute of Technology in June 1977.

He is married to the former Patricia R. Smith of Lansing, New York. They have a son, Aaron, and a daughter, Monica.

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This research was conducted to investigate the relationship of anxiety to biorhythms. Two groups of Air Force Institute of Technology students were administered the State-Trait Anxiety Inventory: the first group received eight surveys over a period of four weeks, the second group received only one survey. State and trait anxiety scores greater than one standard deviation about the group mean were tabulated against 'non-

critical' and 'critical' biorhythm periods. Four hypotheses (and variations) were tested for higher than expected levels of anxiety occurring on critical days. A fifth hypothesis was tested for the rhythmicity of individual A-State anxiety scores.

Hypotheses concerning the existence of relationships of intellectual and composite cycle critical periods to anxiety scores were rejected. Significant results at levels of $\alpha \leq .05$ were found in both groups of high levels of anxiety greater than chance occurring on emotional cycle critical days in persons high in A-Trait when allowances were made for differences in time of birth. The data suggests that a relationship might exist between physical critical days and higher levels of state anxiety. Persons high in A-Trait tend to be more sensitive to biorhythms than persons low in A-Trait. It was concluded that levels of anxiety may be influenced by biological fluctuations (rhythms) over time.